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CONTROL OF DRINKING AND CULINARY WATER ON VESSELS IN INTERSTATE TRAFFIC.

THE SUPERVISION AND CONTROL OF WATER PROVIDED FOR DRINKING AND CULINARY PURPOSES ON VESSELS OPERATING IN INTERSTATE TRAFFIC ON THE GREAT LAKES AND OHIO RIVER DURING THE NAVIGATION SEASON OF 1921, AS EXERCISED BY THE UNITED STATES PUBLIC HEALTH SERVICE IN COOPERATION WITH STATE AND LOCAL HEALTH AUTHORITIES.

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Through the cooperation of State and city departments of health with the United States Public Health Service, an effective supervision and control was maintained over the water provided for drinking and culinary purposes on Great Lakes passenger vessels during the navigation season of 1921; and a careful study was made of the conditions under which such water was being supplied on Ohio River vessels operating out of Cincinnati.

GREAT LAKES VESSELS.

With the approval of the State departments of health concerned, the city health departments at Buffalo, Chicago, Cleveland, Detroit, and Milwaukee were invited to enter into a cooperative arrangement with the Public Health Service, for exercising a uniform control over the drinking water on Great Lakes passenger vessels calling at their respective ports. By the arrangement agreed upon, the local health department at each of these cities detailed a sanitary inspector to collect weekly or semiweekly samples of water from the drinking-water system on each of the passenger vessels calling at its port. Bacteriological analyses of these samples were made at the city laboratories. The routine analytical procedure recommended for this work was the planting of 1 c. c. amounts of the samples on agar and recording the colonies developed after incubation at 37° C. for 24 hours; and the planting of five 10 c. c. portions of the samples in fermentation tubes containing lactose-peptone broth and observing the gas formation in the closed end of the tube after 48 hours incubation at a temperature of 37° C. Other dilutions were frequently made. If gas was noted in any of the fermentation tubes the presence of the *B. coli* group was further investigated according to the practice at the respective laboratories.

Standard survey blanks and cards for reporting the results of the bacteriological analyses were furnished, if desired, by the Public Health Service. These reports were mailed weekly to the headquarters of the Interstate Sanitary District No. 3, in Chicago. In case the results of analyses indicated serious contamination of the drinking water on a vessel, this fact was made known immediately to the district office and a special investigation was made of the water supply system of this ship.

Each month a report of the results of these bacteriological analyses, with pertinent remarks concerning same, was mailed to the headquarters of the shipping companies from whose vessels the samples were collected, with a request that copies of the report be supplied to the master and chief engineer of the vessels concerned. This action was in accordance with the policy of the Public Health Service to stimulate the interest of the shipping officials and seamen in the safety of water provided on their vessels and to educate them in this matter. The interest shown and the attention given by these men to all details concerning the supplying of a safe drinking water on their vessels were very encouraging.

All inspections of the water-supply systems on vessels operating in interstate traffic and the subsequent issuing of certificates of approval or nonapproval were carried out by the Public Health Service. Samples were not collected regularly from all car ferries or freight vessels, although nearly 200 samples were collected and analyzed from vessels of these classes. A sanitary inspector located at Sault Ste. Marie during a part of August and September inspected the water-supply systems on all freight vessels passing through the Government locks during the daytime and made qualitative tests of the distilled water provided for drinking purposes, to check the operation of the distillers.

During the course of the 1921 navigation season 1,802 samples were collected and bacteriological analyses of same were made from the drinking water distributing system or storage tanks on Great Lakes vessels. Nearly 300 "raw" water samples were also collected and analyzed. The collection of samples by months and the number of analyses made by the different cooperating agencies are given in the following tables:

Samples of water collected and analyzed.

April	29	Sept.	197
May	176	Oct.	132
June	380	Nov.	56
July	442		
Aug.	390	Total	1,802

City.	Department.	Samples.
Buffalo, N. Y.	City Health department	411
Chicago, Ill.	do	318
Do	United States Public Health Service	280
Cleveland, Ohio	City health department	281
Detroit, Mich.	do	410
Milwaukee, Wis.	do	102
Total		1,802

Federal regulations as promulgated in Treasury Department Circular No. 234, dated March 3, 1921, provide that on and after April 15, 1921, all water provided for drinking or culinary purposes on vessels operating "in interstate traffic or between ports on or near the frontiers of the United States and ports in the United States" must either be obtained from sources ashore or be treated aboard the vessel by an approved method. Similar regulations, affecting Great Lakes vessels only, were promulgated in Treasury Department Circular No. 72 dated February 12, 1917; and, as a result of same, most of the large passenger vessels on these lakes were equipped with water-treatment apparatus.

Public Health Service inspectors and sanitary engineers made the inspections of the drinking-water system on each vessel, investigating the method of delivery of water to the vessel, its storage aboard, and the condition of the water-treatment apparatus.

The Federal regulations required that no other water than that approved for drinking and culinary purposes be permitted in the galley quarters on vessels, and that at all places on the ship at which other than drinking water was conveniently available for use, signs be placed, warning against the use of this water for drinking. By-passes around water-treatment apparatus or cross connections between the drinking-water system on a vessel and any other water system aboard were not permitted. A "physical" disconnection (by the removal of a short section of the piping and plugging the ends of the "break") was required in these cases. Pipe of lead or lead compounds in the drinking-water distributing system was prohibited; and it was required that all water coolers be so constructed that the water could not come in contact with the ice. The practice of having seamen go into water-storage tanks for the purpose of weekly cleaning was discouraged. Instead of this practice it was recommended that these tanks be sterilized by means of "live" steam or by a solution of hypochlorite of lime, and subsequently flushed. Sterilization with hypochlorite of lime solution proved to be the more satisfactory method. On several vessels high bacteria counts were prevented by periodic sterilization of the distributing system by pumping a solution of this chemical through same.

The passenger vessels on which water used for drinking and culinary purposes was obtained from certified sources ashore were usually excursion vessels operating between ports less than two or three hours running time apart. This water was delivered by means of a hose direct from the hydrants at the dock to delivery pipes leading to the storage tanks on the vessel.

Four methods were employed on Great Lakes passenger vessels last season for disinfecting water taken on en route direct from the Lakes:

1. Filtration and ultra-violet ray disinfection;
2. Heat treatment by steam;
3. Filtration and ozone treatment; and
4. Distillation.

In the following table information is given showing the number of samples collected from Great Lakes passenger vessels last summer, arranged according to the method by which this water was obtained, and the percentage conforming to the Treasury Department bacteriological standards for water provided for drinking and culinary purposes by interstate carriers.

Source.	Treatment aboard.	Number of samples.	Per cent conforming to Treasury Department standards.	
			Bacteria per c. c. 37°-24 hours.	B. coli, positive, 10 c. c.
City water; Great Lakes; chlorine disinfection.	None	240	40.0	78.0
Great Lakes	do	42	40.5	16.7
Do	U. V. R.	1,054	63.6	84.3
Great Lakes, St. Clair and Detroit Rivers	Steam treatment	134	15.7	78.4
Great Lakes	Distillation	128	65.6	92.3
Do	Ozone	16	37.5	43.8
Total		1,614	[1] 55.5	[1] 81.3

[1] Average.

Twenty-eight large passenger vessels of American registry and two Canadian ships, from which samples were collected, were equipped with ultra-violet ray sterilizers. With each installation a pressure sand filter (or filters) was provided for the removal of particles in suspension in the raw lake water prior to its passage through the sterilizer. The turbidity of the waters of the Great Lakes a few miles offshore is usually very low, but for days and sometimes weeks at a time there is sufficient matter in suspension in the water, if not removed by filtration, to seriously reduce the sterilizing ability of the ultra-violet rays emitted from the mercury vapor arc produced in the stem of the quartz lamp. A valve in the discharge line from the sterilizer is provided in all installations, which will permit water to pass to the drinking-water storage tanks only when the voltage across the lamp is that for which the capacity of the sterilizer is rated. On three of the larger vessels, two sterilizing units were connected in series. With the exception of a few instances, when the electrical equipment of the sterilizer was out of order, these sterilizers gave very good service. The engineers on each of the vessels inspected were instructed in the operation of this apparatus. The manufacturers of the sterilizers gave excellent service in this connection.

On five passenger vessels, all of one fleet, apparatus were installed for disinfecting the water taken on en route by heat treatment, using steam direct from the ship's boilers to raise the temperature of the water. With this apparatus the water is taken on through a sea cock by means of a steam ejector and is delivered to a retention tank, where the temperature of the water is raised to about 212° F. Supplementary steam, in excess of that from the ejector, is delivered to the tank if needed, its supply being controlled by a thermostat at the influent end of the retention tank. This tank was designed to hold the water delivered by the ejector at 212° F for five minutes; but this retention period varies, of course, as the steam supply to the ejector affects the delivery of water to the tank. A second thermostat at the effluent end of the tank controls the delivery of the heat-treated water. Until the temperature of the water in the retention tank reaches 212° F. the effluent from same is not discharged into the drinking-water storage tanks. The heat-treated water is cooled by passing through coils in a tank through which lake or river water is circulated. The vessels on which these heat-treatment apparatus were installed operated in the Detroit and St. Clair Rivers, the western end of Lake Erie, and Lake St. Clair. Frequently "aftergrowths" in the treated water developed. Laboratory reports of "innumerable" bacteria developing on agar plates incubated at 37° C. were not infrequent. As a rule, determinations for the *B. coli* group were negative, with the exception of the samples from one boat. Field tests of the operation of the thermostatically controlled valves showed that on all five of these vessels this equipment was out of adjustment. The design of these thermostats used was such that accurate temperature control could be maintained through their regulation of the valve control mechanism, provided these thermostats were properly adjusted. It is understood that the treatment of water used for drinking purposes on these five vessels will be discontinued during the 1922 season, and that such water will be obtained from sources ashore.

On two passenger vessels operating out of Chicago on Lake Michigan, ozone treatment apparatus were installed early in the season; but owing to the unsatisfactory results obtained, it was necessary to disapprove these installations. The installation on each of these vessels consisted of the following units: (1) A pressure sand filter; (2) a time relay operating a valve in the filtered water line, and set so as to permit the delivery of filtered water to the sterilizer only when the ozonator was operating; and when the apparatus was first started, not until one minute after the ozonator had been in operation; (3) a transformer unit, stepping D. C. current from 110 to

12,000 volts; (4) an ozonator with a dielectric system of the grid type, consisting of glass plates 9 by 4 inches, on which the sheet electrodes were mounted; (5) an aspirator for drawing the "ozonized air" into the water-ozone mixers, of which there were 12 units attached to one manifold and discharging directly into a storage tank.

No arrangement was made for preliminary drying of the air drawn into the ozonator. On one of the vessels this apparatus was located in the engine room, and the condensation of moisture between the plates often caused short circuiting in the system. Later, a blower was connected to the ozonator to correct this defect. Tests of the efficiency of this apparatus gave very unsatisfactory results; and it was necessary to issue an unfavorable certificate for both of these vessels, which resulted in the discontinuance of the use of these apparatus and the obtaining of water from certified sources ashore.

On four passenger vessels and about 80 per cent of the freighters operating on the Great Lakes during the season of 1921, distillers were operated for supplying drinking water. On all of the passenger vessels the results were very satisfactory, although some of the engineers claimed that the steam needed for the operation of the distiller was a load on the boilers. Multi-stills were used in each case.

On the freight vessels the distillers gave excellent service where they were properly operated and the apparatus was in good physical condition. The forcing of water through the evaporating chamber was the chief difficulty experienced on this class of vessels, this trouble being confined mostly to one type of distiller. Leaks between the evaporating and condensing chambers were found on some of the distillers, the metal walls having worn through. In the former case the throttling of the water supply to the distiller corrected the difficulty, and in the latter it was necessary to replace the worn parts of the apparatus.

To test the operation of the distillers, qualitative tests, using a solution of silver nitrate, were made of the water in the drinking water storage tanks. If the characteristic cloudy precipitate of silver chloride appeared, it was assumed that the water had not been distilled; or if the chief engineer reported these tanks had been filled only with water from the distiller, an inspection of this equipment was made, which usually located the difficulty. These tests were made as the vessels were visited at various ports or as they were inspected while passing through the Government locks at Sault Ste. Marie. At Cleveland many samples were collected from freight vessels on which it was found that the drinking water tanks had been filled direct from the lakes, and bacteriological analyses frequently showed that this water was contaminated. The following table summarizes the results of bacteriological analyses made of samples of water collected from the drinking water system on Great Lakes freighters:

Source.	Treatment aboard.	Number of samples.	B. coli determinations.	
			Positive, 10 c. c.	Per cent negative, 10 c. c.
City water; Great Lakes: chlorin disinfection.	None	29	6	79.3
Great Lakes direct	Distilled [1]	25	3	88.0
Do	do	50	0	100.0
Do	None	84	8	90.5
Total		188	17	

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[1] Silver nitrate test positive.

OHIO RIVER VESSELS.

Through the cooperation of the Cincinnati Department of Health, samples of water were collected regularly from Ohio River packet passenger and freight vessels calling at that port, and bacteriological analyses of same were made. Investigations of the methods under which drinking water was obtained, delivered to, and stored aboard these vessels revealed some very insanitary conditions.

On most of these river vessels the drinking water was obtained from sources ashore, such as the public water supply at ports of call. It was delivered to the vessel from hydrants in pails, buckets, barrels, and other containers and stored aboard in tanks, open barrels, and coolers. Through careless handling and insanitary storage conditions, this water was frequently contaminated before being served to the public. In the kitchen quarters the hot water used was invariably the river water drawn from the boilers. In some instances, "raw" river water was used in these quarters, being taken aboard in a pail and stored in wooden barrels for use. Ice and water were found in contact in nearly all water coolers on these vessels.

Temporary measures were taken to provide a safe drinking water on this class of boats by requiring more care in the handling and storage of this water, and the results of bacteriological analysis thereafter showed a marked improvement. The bacteria counts were reduced, but continued to be excessively high, while the *B. coli* determinations continued to indicate a reasonably satisfactory control. From July to the end of the calendar year 1921, 263 samples of the water being used for drinking and culinary purposes were collected and analyzed by the Cincinnati Department of Health. The analyses showed only a 5.7 per cent conformity to the Treasury Department standard for bacteria in 1 cubic centimeter of the samples developing on agar plates after incubation at 37° C. for 24 hours, while there was a 62 per cent conformity to the *B. coli* standard. The contaminated water of the earlier samples tended to lower this latter percentage.

A careful study was made of the problem of supplying a safe drinking water to river vessels. It is believed that for the passenger vessels calling regularly at the larger cities, watering stations should be arranged for, at which the vessels could obtain drinking and culinary water from the city mains direct. Such an arrangement would necessitate the extension of a pipe line down the incline to the wharf boats, suitable hose connections to the wharf boat and the vessels, and adequate storage tanks and distributing pipes aboard.[1] It would enable the tanks to be filled without handling the water, the delivery being made by means of the hose and pipe connections and the pressure in the city mains. For craft not calling regularly at ports where safe water can be conveniently obtained, treatment of river water aboard the vessel would be necessary. Distillation would probably be the most satisfactory method of treating this water to render it suitable for human consumption.

THE PUBLIC HEALTH INSTITUTES.

During the winter and spring of 1922 there were held in various cities of the country, under the auspices of State boards of health and the United States Public Health Service, sixteen public health institutes. These schools of instruction, lasting, in most cases, one week, were modeled to a considerable extent upon the Institute on Venereal Disease Control and Social Hygiene held in Washington in November, 1920. They covered, however, a much broader field. Scientific progress in all phases of public health has become so rapid that few of those who are engaged in practical work can keep pace with the many new developments. They need help from time to time in securing essential new facts and inspiration and stimulation for further individual study. The success of the institutes in bringing health officers, private practitioners, educators, heads of institutions, and others concerned into closer touch with some of the newer aspects of public health is no less, because in addition they centered general attention on the problem of public health and helped to create in the communities in which they were held, particularly among the women, active groups interested in a broad and constructive program.

The following table gives the places in which institutes were held, the dates, and the registration at each. In most cases the State board of health was in charge, but generous cooperation was rendered by a number of voluntary organizations. The University of

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[1] For a fuller discussion of this matter see "Sanitary Methods for Supplying Vessels with Water for Drinking and Culinary Purposes, when Obtained from Sources Ashore," Public Health Reports, vol. 37, No. 11, Mar. 17, 1922, pp. 613-630. Reprint No. 734.